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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/812,412

03/30/2004

Steve Wang

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06/28/2006

MORRISON & FOERSTER LLP
1650 TYSONS BOULEVARD
SUITE 300
MCLEAN, VA 22102

EXAMINER

HA, NATHAN W

ART UNIT

PAPER NUMBER

2814

DATE MAILED: 06/28/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/812,412

Applicant(s)

WANG ET AL.

Examiner

Nathan W. Ha

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 06 April 2006.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-9 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1, 2 and 5-9 is/are rejected.
- 7) ☒ Claim(s) 3 and 4 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Objections

1. Claim 1 is objected to because of the following informalities: the phrase "aluminium-oxide" should be changed to "aluminum-oxide". Appropriate correction is required.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1-2 and 5-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Akatsu et al. (US 6,967,136, previously cited, hereinafter Akatsu) and in view of Seidl et al. (2005/0037565, newly cited, hereinafter, Seidl.)

In regard to claim 1, in figs. 6-10, Akatsu discloses a method for producing a deep trench capacitor semiconductor substrate, comprising:

providing a first trench 500 (fig. 6) in the semiconductor substrate 205;
oxidizing, or thermal growth, the semiconductor substrate in the first trench for
providing an oxidized silicon layer 655 (col. 8, lines 29-30);

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depositing a thin conformal layer 660 in the first trench (col. 8, lines 25-35), wherein the thin conformal layer provides a process window, which is as wide as possible for processing a second trench underneath the first trench (figs. 6-7);

removing horizontal regions of the conformal layer and the oxidized silicon layer (figs. 6-7);

providing a second trench 720 underneath the first trench;

increasing a width of the second trench to a widened second trench for providing a bottle structure (figs. 7-8);

removing the conformal layer in the first trench (fig. 10);

depositing a dielectric layer 1110 in the widened second trench (fig. 11, col. 9, lines 49-54); and

filling the widened second the trench with a conductive material 1120 (see fig. 11, and col. 9, lines 53-55.)

Akatsu further discloses that the layer 660 is made of a dielectric material such nitride layer. However, aluminum oxide, an inorganic material, may be used to replace the nitride layer since aluminum had higher dielectric constant which can be applied in thin layer and can be arranged as an insulator and it also facilitate the process of making neighboring layer since the high thermal loading can be avoid. For instance, Seidl discloses an analogous bottle-shaped trench using aluminum oxide as a shielding, or insulator, or ceramic collar, which is widely known. In figs. 1e-1h, for example, the ceramic 6 is deposited in a top trench, and then partially removed to form a second trench. The ceramic made of aluminum oxide is used in order to be arranged as an

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insulator and aluminum oxide further facilitates the process of making neighboring layers since the high thermal loading can be avoid. Furthermore, high-K dielectric material is suitable that can be selectively left in place during a subsequence etch, and the material withstands subsequence high-temperature process including activation and diffusion anneals. However, in regard to the shielding feature, the limitation is a functional limitation. Layers which are made of the same type of material may function the same. In this case the teaching of aluminum oxide is capable to function a shielding layer. See also paragraphs [0067-0068].

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to use a well known high-k dielectric material as taught by Seidl in order to take the advantages as mentioned above.

In regard to claim 2, wherein after increasing the width of the second trench to the widened second trench a doping the semiconductor substrate in the widened second trench is provided for providing a first electrode in order to activate the device prior to fill the opening. See Akatsu's col. 9, lines 50-55.

In regard to claim 5, Akazu further discloses:

depositing the silicon nitride and oxidize the layer to providing the dielectric, for example, SiON. The oxygen in the compound SiON shows that the silicon nitride is been oxidized. See Akatsu's col. 9, lines 50-58.

In regard to claim 6, the polysilicon is deposited in the wider trench after widened it (Akatsu's col. 9, lines 49-52.)

In regard to claim 7, the aluminum layer is Al₂O₃ (see Seidl's paragraph [0076].)

In regard to claim 8, Akatsu, or Seidl, further discloses the step increasing the width of the second trench, or creating the bottle-shape, to widen the second trench, by a wet etching process. See Akatsu's col. 6, lines 52-56 and col. 8, lines 65-67, and also, fig. 7. See also, Seidl's paragraph [0055].

In regard to claim 9, the increasing the width of the second trench for providing the bottle structure is provided by RIE etching process in order to provide a directional process, or to vertically remove the material on the surface. It is common and known as anisotropic. See Akatsu's col. 5, lines 60-65 and Seidl's paragraph [0054].

2. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Akatsu and Seidl as applied to claims 1-2 and 5-9 above, and further in view of Chen et al. (US 2004/0214391, newly cited, hereinafter, Chen.)

In regard to claims 3-4, the combination of Akatsu and Seidl discloses all of the claimed limitations as mentioned above, except depositing a rugged polysilicon layer in the widened trench by a hemispherical grain polysilicon. It should be noted that the use of rugged silicon in a trench is widely used in trench capacitor devices since it provide larger surface area, therefore, increasing capacitance. For instance, Chen, in figs. 1f-1h, discloses an analogous bottle-shaped and further depositing a rugged polysilicon, or hemispherical grain silicon, HSG, in the widened trench 113 by a conventional method, deposition, thereby increase the surface area of the capacitor plate. See also, paragraph [0024].

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to fill the bottom trench with a well known rugged

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polysilicon as taught by Chen in order to increase the surface area of the capacitor plate.

Response to Arguments

5. Applicant's arguments with respect to claims 1-9 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

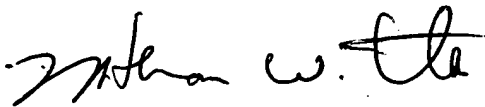
A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nathan W. Ha whose telephone number is (571) 272-1707. The examiner can normally be reached on M-TH 8:00-7:00(EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on (571) 272-1705. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

A handwritten signature in black ink, appearing to read "Nathan W. Ha". The signature is stylized with a large initial "N" and a cursive "W. Ha".

Nathan Ha
Jun 6, 2006